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EXPERIMENTAL CONTROL OF THE
MOUNTAIN PINE BEETLE IN WHITEBARK PINE
YELLOWSTONE NATIONAL PARK
1939

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EXPERIMENTAL CONTROL OF THE MOUNTAIN PINE BEETLE IN WHITEBARK PINE YELLOWSTONE NATIONAL PARK 1939

Experiments conducted for a number of years have indicated the effectiveness of certain fuel-oil-base penetrating sprays for controlling the mountain pine beetle in lodgepole pine. It was decided to test one of the most effective of these formulae, comprising 4 parts of diesel oil, one part of orthodichlorobenzene and 3/4 pound of naphthalene flakes per gallon of oil, on brood of the same bark beetle in whitebark pine. Conditions in the latter tree species vary considerably from those in lodgepole pine. Bark is thicker in whitebark pine and presents a smoother surface, both of which conditions could be expected to offer greater resistance to absorption of oils. Whitebark pine sites are cooler, which might render the spray less effective by decreasing rate and total absorption of oil because of increased viscosity. In whitebark pine considerable variation occurs in time of attack and brood development, which would result in there being a wide range of bark moisture, from the sap-saturated green stage at the time of and following recent attack to the almost dry condition immediately preceding emergence. Green bark is practically non-absorptive of oil, probably due to its sap-saturated condition. In lodgepole pine it was found that as the bark begins to dry following attack by the mountain pine beetle, its ability to absorb the oil-base spray increases. It is under the drier bark of lodgepole pine that the best control has been secured and similar results might be expected in whitebark pine.

The area selected for the experimental spraying of whitebark pine was on the southwest side of Mt. Washburn at an elevation of approximately 9,000 feet. The exposure varies from west to north, sloping approximately 30° and supporting a stand chiefly of whitebark pine but containing some Engelmann spruce, lodgepole pine, and alpine fir. Stand density varied from medium to slightly heavier than medium for stands of this type.

The 28 trees selected for the experiment were sprayed on August 13, 1939. Of the above number, 22 had foliage which was at least 50 percent red, ranging from that amount to 100 percent. These 22 trees represented advanced stages of bark beetle development. In addition five trees of more recent date of attack and less advanced brood development were similarly treated. They showed very little red foliage; in fact, only one had any of that color--30 percent; with the other four having 60 or more percent green needles and the remaining foliage fading or sorrel. An additional treated tree contained only the egg stage of brood development and foliage had not even started to fade. Although good control was not expected on these six trees, it was considered worth while to test the effectiveness of the spray under such adverse conditions.

To secure an effective measure of the lethal effects of the spray the basal five feet of one-half the circumference of infested trees was treated, the remaining half of the bole being left untreated to serve as a check. To secure adequate and uniform coverage the formula was applied in a fine spray until the bark surface glistened and the oil started to run. When the trees were examined about one month later the

status of brood development, foliage color, and bark conditions was noted. Intensive examination of treated trees consisted of removing definite areas of bark, determining the number and status of each brood stage and bark condition as to degree of moisture and thickness. In addition enough of the treated area was extensively sampled to determine the representativeness of the intensive examination . Intensive inspection of the foliage was made in order to determine if any relationship existed between its color and brood development. Some of the data just discussed are presented in table I.

TABLE I

FOLIAGE COLOR AND BROOD CONDITION
IN 22 MOUNTAIN PINE BEETLE
INFESTED WHITEBARK PINE
YELLOWSTONE NATIONAL PARK

Percent of each stage of living brood at time of examination				Foliage color Percent of		
Larvae	Pupae	N.A.	Emerg.	Fading	Sorrel	Red
7.4	6.2	63.6	22.7	.2	5.2	94.6
Number of trees showing each condition						
3	4	16	11	1	7	20

From an inspection of the data it is seen that a high percent of red foliage is an indication of advanced brood development. Only one of the 22 trees showed as little as 50 percent red foliage, six showed 80 to 95 percent, and the remainder 100 percent. As to brood, only two trees failed to show new adults or new adult emergence holes. One contained no brood, the other pupae, and the remaining 20 no less than 57 percent new adults.

Adverse weather conditions shortly prior to and during the time of examination made any attempt to evaluate bark moisture in relation to insect survival on treated areas so uncertain that it has not been presented.

Brood showed decided change during the period between treatment and examination as may be seen in taule II.

TABLE II

BROOD DEVELOPMENT OF THE MOUNTAIN PINE BEETLE IN WHITEBARK PINE BETWEEN THE TIME THE SPRAY BECAME EFFECTIVE AND THE SUBSEQUENT EXAMINATION WAS MADE

Percent of each brood stage at the time it was killed by spray			Percent of each stage of living brood at the time of examination			
Larvae	Pupae	N. A.	Larvae	Pupae	N. A.	Emerge. Holes
42.7	19.3	38.0	7.4	6.2	63.6	22.7

It is not known how quickly the insects are killed by the spray, but its action is probably quite rapid judging by the decided advance in development noted in brood from the untreated section compared with the status of the brood that was killed by the spray.

The effectiveness of the spray is indicated by the data presented in table III.

TABLE III

CONTROL SECURED BY TREATING MOUNTAIN PINE BEETLE
INFESTED WHITEBARK PINE WITH PENETRATING OILS
YELLOWSTONE PARK - 1939
TREES HAVING FROM 50 TO 100 PERCENT RED FOLIAGE

	Status of brood in									
	Treated area					Untreated check area				
	Dead		Living		No. of	Dead		Living		No. of
No. of trees	No. of brood per sq. ft.	Per-cent of total	No. of brood per sq. ft.	Per-cent of total	sq. ft. of bark exam.	No. of brood per sq. ft.	Per-cent of total	No. of brood per sq. ft.	Per-cent of total	sq. ft. of bark examined
22	19.7 ±15.7	96.4	.7±.8	3.6	21.75	.4±.8	2.8	13.3 ±28.5	97.2	13.25

The few insects on which the treatment does not seem to have been effective may have been reduced more than the data indicates, as much of the credited survival was for emerged insects.

Of the nine trees credited with survival at the time they were examined six showed emergence holes and of the latter, four had shown emergence holes at the time they were treated. However, it was necessary to consider all emergence holes in treated areas as having been made by brood after the trees had been treated due to inability to determine whether they had been made prior to or following treatment without consuming a prohibitive amount of time in making pre-treatment bark surface examinations.

Estimated survival was quite uniformly low, in only one case equaling 20 percent, reaching 14 in two cases, and not exceeding 10 percent in the remaining few trees, in which some living insects were found.

Bark thickness, a factor found to influence survival of mountain pine beetle brood in lodgepole pine, apparently had the same effect in whitebark pine. Plotting survival against bark thickness, thrown into four average thickness classes, gave the results shown in table IV.

TABLE IV

EFFECT OF BARK THICKNESS ON SURVIVAL OF
MOUNTAIN PINE BEETLE BROOD IN WHITEBARK PINE
TREATED WITH PENETRATING OIL
YELLOWSTONE PARK - 1939
TREES HAVING 50 TO 100 PERCENT RED FOLIAGE

Bark thickness	.15	.22	.3	.4
Percent control secured	98.5	97.4	95.2	89.1

From the preceding data it may be seen that survival increases as bark thickness increases.

To test the effectiveness of the spray on trees of comparatively recent attack six such trees were treated in the same manner as the 22 previously discussed. Brood in these six trees was only in the egg and small larval stages and the bark contained considerably more moisture than the 22 trees just discussed. As was pointed out in the first part of this report, increasing bark moisture is known to favor increase in survival of brood under oil-sprayed lodgepole pine bark by apparently reducing its oil-absorbing ability, and it is believed conditions in the two tree species are comparable in that respect. The brood being under and protected by the bark, the latter must be sufficiently dry to absorb enough oil to kill the brood. Fortunately, larvae, in the process of feeding and growth, interlace the bark with their mines, thus promoting air circulation and drying of the bark, which in turn promotes the absorption of the oil-base spray.

When these six whitebark pine were examined it was found that brood was almost entirely confined to the egg and small larval stages. The greater protection afforded to the brood by the moist and but lightly mined bark resulted in less observed mortality at the time of examination than had been noted in the 22 trees having drier, more heavily mined bark and more advanced brood development. The data from five of the trees are shown in table V. Data from the sixth tree are not included, because only eggs were present, none had hatched, and attempts to determine whether they were living or dead would probably have yielded data of uncertain value.

TABLE V

EFFECTIVENESS OF PENETRATING OIL SPRAY IN CONTROLLING MOUNTAIN PINE BEETLE BROOD IN WHITEBARK PINE OF COMPARATIVELY RECENT ATTACK 1939

No. of trees treated	Developmental stage of MPB brood	Brood in treated portion: Dead: No. per sq.ft.	Dead: % of total brood	Living: No. per sq. ft.	Living: % of total brood	Sq. ft. of bark exam.	Brood in untreated portion: Dead: No. per sq.ft.	Dead: % of total brood	Living: No. per sq.ft.	Living: % of total brood	Sq.ft. of bark exam.
5	Eggs* larvae	35.2	81.0	8.2	19.0	4.0	-	-	100	100	1.0

*Eggs not considered in count of dead and living. See subsequent discussion for explanation.

It is readily seen from the preceding table that control secured on these trees was good but considerably less than on those which showed more advanced brood development and foliage fading.

In spite of a probable small amount of oil absorption, it was noted that most of the parent adults had been killed, even in wet and

green bark, in contrast to the light normal mortality found in the untreated area. Furthermore, in the treated area, many eggs, which comprised a large part of the brood, had not hatched and were obviously dead. The remainder, it is believed, will show high mortality due to their already long overdue hatching time. Previous experience with the larval stages has shown that where the spray causes suspended or retarded development death of the insects is usually the final result. There are no reasons to believe the egg stage would react any differently to the spray. That development was suspended or retarded is indicated by the proportionately few eggs in adjoining untreated areas and the large percent of larvae in contrast to all eggs and no larvae in the treated area. Because of the apparently similar environmental conditions it is felt that the controlling factor is the spray.

In the first part of this report the effect that bark moisture has on brood survival under treated bark was briefly discussed. Data secured concerning that factor are presented in table VI.

TABLE VI

EFFECT OF BARK MOISTURE ON SURVIVAL OF BROOD OF THE MOUNTAIN PINE BEETLE UNDER BARK SPRAYED WITH PENETRATING OIL
WHITEBARK PINE - MT. WASHBURN
1939

Bark moisture	Dry	Dry to moist	Dry to green	Moist	Moist to green	Green
Brood mortality	100	97.6	100	96.0	87.5	13.6
No. of 1/4-sq.-ft. samples	3	8	3	75	6	1
Average bark thickness in inches	.18	.22	.17	.25	.22	.2

From the preceding data it is seen that there is a general trend toward decreasing mortality with increasing bark moisture. However, the samples, for all but the moist condition of bark, are too few to furnish what may be considered a representative sample. In addition there is a trend to show increased bark thickness with increased moisture. Increase in bark thickness is also known to favor survival. For the above reasons the data showing increase in survival with increase in bark moisture, must be considered as only indicative and not conclusive evidence.

A study of the relation of tree diameter to abundance of insects revealed no definite trend. Extremes of insect abundance were found just as frequently in large as in small-diameter trees. The average size tree treated was about 11.5 inches in diameter, with 19 trees between 10 and 13 inches and 24 between 8 and 16 inches. The remaining four were 19, two of 20, and one 26 inches in diameter.

DISCUSSION OF RESULTS

In spite of the fact that statistical analysis reveals that the data of only two of the 22 trees in the larger test fall outside the allowable limits of variation, which is the mean plus or minus 1-1/2 times the probable error, it is felt that this experiment should be continued during the coming season. The effect of different exposures on control by the oil spray were not sufficiently tested in the preliminary experiments conducted during the past season.

The surprisingly good control obtained when trees of comparatively recent date of attack were treated warrants further tests on such trees. In particular, examinations at a greater interval after treatment should

be made in order to test the final effect of suspending or retarding brood development resulting from the action of the oil. It may be found that the oil finally causes practically complete mortality in spite of the presence of considerable moisture in the bark.

A further test that should be made is to determine the effect of spraying at different times of the season on amount of control. The tests made in 1939 were in mid-August. Future tests should be made in June, July and September in order to know the length of season in which effective control can be secured.

The experiments conducted in 1939 place a much more favorable outlook on possibilities of control of the mountain pine beetle in white-bark pine by penetrating oil, than was anticipated. While a definite conclusion as to effective control can only be drawn for west and north slopes and on brood in advanced stages of development, it is probable the oil will prove effective over a much greater range of brood development, length of season, and site conditions.

SUMMARY

During the season of 1939 22 mountain-pine-beetle-infested white-bark pine at an elevation of 9,000 feet were treated with penetrating oil. Excellent control was secured in trees containing advanced stages of brood development. Brood development seems to be fairly closely correlated with foliage discoloration, red foliage being an almost definite indication that part of the brood is in the new adult stage.

Good control was also secured in six trees having less advanced brood development, and the suspended or retarded growth noted may have resulted in even better control than the data indicate.

It is planned to continue the experiment during the coming field season (1940) in order to determine further possibilities of the method in whitebark pine.